

— in particular, the routing of samples and other liquids on chip — has been demonstrated previously, the vast majority of the steps required for CE must still be done by laboratory researchers who manually perform the necessary activities off chip. This work represents the demonstration of a fully automated end-to-end CE-LIF analysis.

All of the critical functions of a future *in situ* instrument including mixing, dilution, derivatization, and separation of samples have been successfully performed on a chip. This technology and the experimental protocols developed to use it will be the heart of any future lab-on-a-chip based instruments for *in situ* life detection on the surface of a ex-

traterrestrial body, but can be readily adapted to a number of biological and defense applications.

This work was done by Peter A. Willis, Maria Mora, Harold F. Greer, and Anita M. Fisher of Caltech and Sherrisse Bryant of Louisiana State University for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-47888

Techniques for Down-Sampling a Measured Surface Height Map for Model Validation

NASA's Jet Propulsion Laboratory, Pasadena, California

This software allows one to down-sample a measured surface map for model validation, not only without introducing any re-sampling errors, but also eliminating the existing measurement noise and measurement errors.

At present, the surface map of an optic is measured using an interferometric instrument such as a Zygometer. In such a case, the measured surface map has a high resolution and needs to be down-sampled before using it in model validation software. The software tool of the current two new techniques can be used in all optical model validation processes involving large space optical surfaces.

Down-sampling of a surface map is accomplished by using the analytical ex-

pressions of Zernike-polynomials of the given surface map for a low-spatial frequency component and the spectrum or the power spectral density (PSD) data of the given surface map for mid-spatial frequency component. The challenge is to decrease the matrix size of a measured optical surface height map to match it with a model validation software tool.

During the down-sampling of a surface map, this software tool preserves the low-spatial frequency characteristic of a given surface map through the use of Zernike polynomial fit coefficients, and maintains mid-spatial frequency characteristics of the given surface map by the use of the spectrum or the PSD data of the given surface map calculated

from the mid- and the high-spatial frequency components of the original surface map.

These new methods do not introduce any aliasing and interpolation errors as is done by the conventional interpolation and FFT-based spatial-filtering method. Also, they automatically eliminate the measurement noise and other measurement errors such as artificial discontinuity.

This work was done by Erkin Sidick of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

This software is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-47711.

Multi-Component, Multi-Point Interferometric Rayleigh/Mie Doppler Velocimeter

Langley Research Center, Hampton, Virginia

An interferometric Rayleigh scattering system was developed to enable the measurement of multiple, orthogonal velocity components at several points within very-high-speed or high-temperature flows. The velocity of a gaseous flow can be optically measured by sending laser light into the gas flow, and then measuring the scattered light signal that is returned from matter within the flow. Scattering can arise from either gas molecules within the flow itself, known as Rayleigh scattering, or from particles within the flow, known as Mie scattering. Measuring Mie scattering is the basis of all commercial laser Doppler and particle imaging velocimetry systems, but particle seeding

is problematic when measuring high-speed and high-temperature flows.

The velocimeter is designed to measure the Doppler shift from only Rayleigh scattering, and does not require, but can also measure, particles within the flow. The system combines a direct-view, large-optic interferometric setup that calculates the Doppler shift from fringe patterns collected with a digital camera, and a subsystem to capture and re-circulate scattered light to maximize signal density. By measuring two orthogonal components of the velocity at multiple positions in the flow volume, the accuracy and usefulness of the flow measurement increase significantly over single or non-

orthogonal component approaches.

The subject architecture can be combined with CARS (coherent anti-Stokes Raman spectroscopy) to provide temperature and composition of the measured flow. The system is also capable of characterizing high-velocity flames, up to 2,400 K, which is useful in analyzing high-speed combustion in fighter jet engines, scramjet engines, and even potentially in gas turbines.

This work was done by Paul M. Daney and Joseph W. Lee of Langley Research Center and Daniel Bivolaru of The George Washington University — Hampton, VA. Further information is contained in a TSP (see page 1). LAR-17235-1